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Synthetic post-Asymptotic Giant Branch evolution: basic models and applications to disk populations

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abstract We explore the realm of post-Asymptotic Giant Branch (post-AGB) stars from a theoretical viewpoint, by constructing synthetic population of transition objects, proto-Planetary Nebulae, Planetary Nebulae Nuclei, and post-Planetary Nebulae objects. We use the Montecarlo procedure to filter out the populations accordingly to a given set of assumptions. We explore the parameter space by studying the effects of the Initial Mass Function (IMF), the Initial Mass-Final Mass Relation (IMFMR), the transition time ($t_{\rm tr}$), the envelope mass at the end of the envelope ejection ($M_{\rm e}^{\rm R}$), the planetary nebula lifetime $t_{\rm PN}$, the hydrogen- and helium-burning phases of the central stars. The results are discussed on the basis of the HR diagram distributions, on the $M_{\rm V} - t$ plane, and with mass histograms. We found that: (1) the dependence of the synthetic populations on the assumed IMF and IMFMR is generally mild; (2) the $M_{\rm e}^{\rm R}$ indetermination produces very high indeterminations on the $t_{\rm tr}$ and thus on the resulting post-AGB populations; (3) the synthetic models give a test check for the ratio of He- to H-burning PNNi. In this paper, disk post-AGB populations are considered. Future applications will include Magellanic Clouds PNe, and populations of bulges and elliptical galaxies.